of the fibre contributes to the formation of the substance, is shown by the formation of a similar compound from pure cellulose and dextrin. A chlorinated product ($C_{20}H_{16}Cl_4O_{10}$) has been obtained from this black substance, its properties are similar to those of the aromatic substance described in a previous paper (*loc. cit.*). The production of this spongy substance is usually a destructive one, and attended with an evolution of CO_2 and the production of acetic acid, &c. It is not, however, necessarily so, for when the action of the sulphuric acid is arrested before the evolution of carbonic dioxide, a reddish brown solution is obtained, from which when poured into water a copious flocculent precipitate is obtained, of a body very similar in chemical properties to the black substance described above. The chlorine substitution products are easily converted into astringent bodies, producing dark-coloured precipitates with iron salts and copious coagulation with gelatine. These facts, together with the following :—(*a*) Meissner and Sheppard's conclusion that the hippuric acid of herbivorous urine is derived from an aromatic body present in the fodder, apparently a form of cellulose, which the authors have identified as similar to the characteristic consitituent of bast fibre; (*b*) the previous demonstration by the authors of the homogeneous nature of jute fibre, and that in its resolution the percentage yield of cellulose may be increased apparently at the expense of the aromatic constituent; (*c*) that the process of liquification (or the formation of tannin-like substances) is said by microscopists to be due to an intrinsic modification of the substances of the cell-walls, *i.e.*, of the cellulose, and not to an infiltration of the substances present in the cell cavity; (*d*) the numerous cases in which tannic acid is formed at the expense of plant structures of the nature of cellulose—lead the authors to conclude that, until the contrary is proved, lignin must be regarded as derived from cellulose by chemical modification. The spongy black substance, previously described, dries to a hard mass resembling cannel coal, with which the authors have compared it, and have obtained similar products of chlorination and nitration, and further support of the opinion that coal is not carbonaceous in any more special sense than alcohol, but is rather, as supposed by Balzer, composed of C, O, H, N bodies, which are genetically, if not homologously related. The authors suggest that cellulose, lignite, peat, lignin, and anthracite are terms of an infinite series differentiated under the conditions of their formation.

Hydration of Salts and Acids, by C. F. Cross, B.Sc.—The method adopted by the author for investigating the rate of hydration of a substance consisted in exposing about 1 gramme of the substance in a bell-jar of 2000 c.c. capacity, to an atmosphere saturated with aqueous vapour. After a critical investigation of the probable errors, the "Jolly" Federwaage was used to make the numerous weighings required, and thus the method of observation was rendered very expeditious. The paper contains diagrams representing the velocities of hydration for certain salts and oxides. The author has observed that, under these "artificial" conditions of exposure, all the soluble salts examined deliquesce. This takes place in some cases without previous hydration, *e.g.*, with potassium bichromate, and in such cases the water may be removed by pressure between blotting paper. In other cases, *e.g.*, with $CuSO_4$, the salt deliquesces after uniting with water of chemical hydration, and in a different manner. It would therefore appear that the continuity of the phenomena of hydration and solution, as regards the determining cause, is demonstrated by these observations.

On Colliery Explosions, by W. Galloway.—The author gave an account of his experiments made to show the influence of coal-dust in colliery explosions. In July, 1878, he made three sets of experiments with different kinds of apparatus. In the first set, in which coal-gas was used instead of fire-damp, and the gas and air were carefully measured, and then coal-dust added, it was shown that 2 per cent. of gas, mixed with air, was rendered inflammable when coal-dust was added; 3 per cent. of gas made this mixture slightly explosive; 4 per cent. made it still more explosive; and 5 per cent. produced a violent explosion. The total quantity of gas and air mixture was little more than a cubic foot. In the second set it was shown that the return air of a mine containing 2 per cent. of fire-damp became inflammable when coal-dust was added to it. In the third set the explosion of a mixture of air and fire-damp was made to raise and ignite coal-dust scattered along the floor of an artificial gallery 70 or 80 feet long, and 14 inches square inside. The flame of the fire-damp explosion alone was found to be 7 feet or 8 feet long; the flame of coal-dust in pure air was 35 feet or 40 feet long; and the flame of coal-dust in the return air employed in the first set of experiments was 80 or 90 feet long. The publication of these results called further attention to the subject, and after the Seaham explosion the Home Secretary requested Dr. Abel to inquire, amongst other things, into the influence of coal-dust in promoting that disaster. Prof. Abel made experiments near Wigan, and obtained results similar in kind to the author's, but different in some respects. In July of the present year the author made experiments with apparatus of the following description: A sheet-iron cylinder 6 feet long by 2 feet in diameter, closed at one end and open at the other, had its open end bolted to a wooden gallery 126 feet long by 2 feet square inside. One end of the wooden gallery was thus closed by the sheet iron cylinder, an explosion chamber, and the other end was open. Six sheets of newspaper were placed between this open end of the explosion chamber and this gallery, and a tight joint was ensured by means of screws. Rather less than 2 cubic feet of fire-damp was carefully measured and introduced into the explosion chamber. The wooden gallery contained only pure air. The air and fire-damp contained in the explosion chamber was thoroughly mixed by means of an appropriate mechanical arrangement, and the mixture was exploded. The explosion burst the sheets of paper, and the resulting flame travelled about 12 feet or 14 feet along the gallery, and as suddenly disappeared. The gallery was then strewed with a layer of the coal-dust from $\frac{1}{8}$ inch to $\frac{1}{4}$ inch thick along its floor, and some was placed on shelves which stood in sets of three, one above the other, at distances of 10 feet from each other, along the gallery. The same arrangement as before was then made in regard to preparing for a fire-damp explosion, exactly the same quantity of fire-damp being measured, mixed, and exploded. By this explosion of the fire-damp mixture the coal-dust was raised in a cloud throughout the whole length of the gallery, part of it was projected out into the air to a distance of 20 feet or 30 feet beyond the end, and, after the lapse of an appreciable interval of time, the flame found its way to the end of the gallery and flashed out through the cloud of dust to a greater or less distance according to circumstances. The greatest length of flame thus obtained with coal-dust and pure air was 147 feet on one occasion, and from 100 feet to 140 feet very often. He considered that these results proved in the most convincing manner that coal-dust formed an inflammable mixture with pure air, and they settled once for all the question as to how an explosion in one district of a dry and dusty mine could penetrate to the most distant parts of every other district of the workings in the same mine. In conclusion the author spoke of the necessity of keeping the floors of mines damp, and thus lessening the dangerous influence of coal-dust.

SECTION C—GEOLOGY

A preliminary Account of the Working of Dowkerbottom Cave in Craven during August, 1881, by E. B. Poulton, M.A., F.G.S.—Dowkerbottom Cave is 1250 feet above the sea, between Arncliffe and Kilnsey. Its mouth is merely a fall in the roof of the cave, which stretches from either end of the fissure thus formed. The original mouth is not now visible, but is probably to be found at the foot of a slope to the south. During most of its course the chambers and passages of the cave are not separated by any great thickness of rock from the ground above, and thus other falls must be expected to occur. The eastern division of the cave is about 450 feet long, and has three fine chambers separated by two passages, the first very short, and the second very long. This division ends under high ground, and the true mouth must be in the other, or western cave. The last chamber is characterised by mechanical deposits—blocks of limestone fallen from the roof and a stiff brown clay beneath. In the other chambers and passages are chemical deposits—hard and soft stalagmite. The western division is smaller, but also contains three chambers and two passages. It must be about 250 feet long. Chemical deposits, with some falls from the roof, are present throughout. In former workings by Mr. Farrer, Mr. Denny, and Mr. Jackson, the first chambers were explored in their surface layers at least, and here were found the numerous metal and bone ornaments and implements, together with the bones of animals usually found in the historic layers (of Romano-British age) in caves. The second passages have also been worked, and part of the second chamber on the eastern side. Other parts of the cave appear to be quite untouched. The great

difficulty in working the cave is the removal of the *débris* to prevent its interfering with further work. We therefore put up a windlass over the eastern entrance and cleared a way for barrows through the talus below. Beneath the talus the black earth, in which remains had been previously found, was seen, and many articles of Roman age were taken from it. Chamber III. was marked into parallels, and these into squares. In the centre we sank a shaft and passed through the following layers:—(1) *Romano-British layer*, a black earth with pottery, ornaments, &c., and numerous bones, usually from 1 to 2 inches thick; (2) *hardish stalagmite*, about 6 inches thick, in one place containing the bones of a dog or small wolf; (3) *soft stalagmite* 4 inches thick; (4) *hardish stalagmite* 6 inches thick; (5) *soft stalagmite* 2 feet 6 inches thick; (6) *stiff brown clay* with large angular blocks of limestone fallen from the roof firmly imbedded in it. This layer was 8 feet deep, as far as we saw it. The last two feet are laminated and contain smaller blocks. At the depth of about 12 feet from the surface we came upon part of the solid limestone floor or side of the cave, sloping steeply downwards. There were no indications of a change in the nature of the deposit at the junction with the limestone, and the clay appears to extend much deeper than the level at present reached. Thus below the stalagmite purely mechanical deposits succeed, and no limestone blocks are found above this horizon, although the stalagmite has been removed over a large part of the floor of the chamber. No traces of a fauna have been as yet found below the first hardish stalagmite; indeed all the deposits passed through below the stalagmite indicate the former presence of a still lake in which the great thickness of clay slowly accumulated. Further work was stopped by the heavy rain which flooded the shaft dug in the clay. It is interesting to note that the former condition of Chamber II. is identical with the present state of the third chamber in the preponderance of mechanical over chemical deposits. The change from mechanical to chemical deposits was probably produced by a change from accumulation in still water to accumulation in running water. Possibly also the absence of blocks fallen from the roof in the stalagmite may be due to the bicarbonate of lime contained in the water which percolated through the roof, cementing together the limestone blocks. The absence of this cement when the clay was deposited may be due to the absence of solvent power in the water which then percolated through the roof. For the carbon dioxide would not be evolved from a soil deficient in organic matter, as the soil covering the Yorkshire hills for a period long after the Glacial period must have been. The author expresses his best thanks to Mr. J. R. Tennant of Kildwick Hall, Leeds, and to Mr. J. R. Eddy of Carleton, Skipton, who gave, on behalf of the Duke of Devonshire, the permission to work the cave, and further aided with kind help and advice all through the work.

On Asteromilia Readi, a New Species of Coral from the Oligocene of Brockenhurst, by Prof. P. Martin Duncan, F.R.S.—The author described the characters of this coral, placing it in the genera established to include certain corals from the West Indies, and some dredged up in the Carribean Sea by Count Pourtalès. He referred to the genus Madrepora, which lives in twenty to twenty-five fathoms, 74° Fahr. temperature, reef-building coral, or on banks in a turbulent sea. The specimens are generally rolled, but some are absolutely perfect, and clearly give the history of the physical conditions of the close of the Eocene period in the south of England, which then resembled the climate of the Bermudas.

On the Formation of Coal, by E. Wethered, F.G.S., F.C.S.—The author considers (1) that coal was not formed from vegetation of the Lepidodendroid type, and that therefore the Stigmaria found in the underclays are not the roots of the vegetation which gave rise to the coal; (2) that the varieties of coal and the change which sometimes takes place in one and the same seam are not due to metamorphism, nor are they dependent upon the contorted state of the surrounding strata, but arise from the greater or less chemical decomposition of the vegetable mass, influenced by the circumstances under which it was submerged. On the land grew the vegetation of the period, represented by the Lepidodendrons, Sigillaria, Calamites, &c. As the land sank and the waters encroached, the land vegetation was gradually washed away, but the roots remained in many cases, and those which offered the greatest resistance to decay are the ones preserved in a fossil state—hence the occurrence of Stigmaria. As the waters advanced the ground would become swampy, and then we might expect to see spring up reeds, mosses, and other vegetation suitable to the changed condition; it is to vegetation of this kind that the author ascribes the formation of coal. With a view of ascertaining whether the chemical composition of the beds which overlie a seam of coal which has changed from bituminous to anthracite also changed, the Welsh "nine-feet" seam was selected, which near Cardiff is semi-bituminous, and at Aberdare becomes anthracite. Specimens of the overlying strata were selected from the two districts at each foot above the coal for five feet; these were analysed, and it was found that the beds from near Cardiff were considerably more argillaceous and, as a whole, less ferruginous than those at Aberdare.

On the Palæozoic Rocks of North Devon and West Somerset, by W. A. E. Ussher, F.G.S., Geological Survey of England and Wales.—The classification adopted is as follows:—

LOWER DEVONIAN	FORELAND GRITS	Red and purplish grits, fine-grained, and in places siliceous.
	LYNTON BEDS	Grey, even-bedded, and jointed grits, grey schists, and schistose grits with films of calcareous matter.
MIDDLE DEVONIAN	HANGMAN GRITS	Coarse white quartzose, red-speckled grit, in and upon red and grey rather fine-grained grits associated with shaly and slaty beds.
	ILFRACOMBE SLATES PASSING INTO MORTE SLATES	Grey and silvery slates and shales with arenaceous films, and impersistent bands of limestone passing into pale greenish unfossiliferous quartzose slates.
UPPER DEVONIAN	PICKWELL DOWN BEDS	Indian-red slates upon red, green, and grey grits, with local purple slate basement-beds passing into the Morte slates.
	BAGGY BEDS	Green slates with *Lingqula;* brown micaceous grits with *Cucullæa*, positions of these horizons apparently reversed near Wiveliscombe.
	PILTON BEDS	Bluish and greenish grey argillaceous slates, with occasional thin films of limestone and masses of grit (as at Braunton, &c.).

The Foreland Grits occupy an area (superficial) of thirty square miles, extending from Countesbury to Dunster. The Hangman Grits form the range which includes Dunkery Beacon, also the whole northern part of the Quantocks. Their relations to the Ilfracombe Slates are much complicated by faults around Croydon Hill and on the Quantocks; and the prevalence of grits in the Ilfracombe series, whilst indicative of lithological assimilation, makes the boundary rather indefinite.

On the Characters of the "Lansdown Encrinite" (*Millericrinus Pratii*, Gray, sp.), by P. Herbert Carpenter, M.A.—The "Lansdown Encrinite" is a species of *Millericrinus* (*M. Pratii*, Gray, sp. = *Apiocrinus obconicus*, Goldfuss) from the Great Oolite on the top of Lansdown, near Bath. It is remarkable for the very great variation in the characters of its stem and calyx. The former may reach 50 mm. in length, and consist of seventy discoidal joints; or there may be less than ten joints, the lowest of which is rounded off below, and its central canal closed up. Various intermediate conditions may occur between these two extremes, while in some specimens there may be only two to four stem-joints; and in one case the whole stem is represented by a slightly convex imperforate plate on which the basels rest. This specimen, taken by itself, would be naturally regarded as a *Comatula* of advanced age, in which the cirrhus-sockets had disappeared from the centre dorsal just as they do in the recent *Actinometra Jukesii.* The general appearance of the calyx is very similar to that of *Pentacrinus Wyville-Thomsoni* from the North Atlantic. But it is remarkable for the number of small intercalated pieces which it may contain. The basels are frequently separated from one another, or from the radials, by minute plates which, while regularly developed all round the calyx in some specimens, are entirely absent in others. The nearest allies of *M. Pratii* seem to be *M. Munsterianus*, var.

Buchianus and *M. Nodotianus*. It stands on the extreme limit of the genus, connecting it with *Pentacrinus* on the one hand, and with the free *Comatulidæ* on the other. It is thus a synthetic type, as would naturally be expected from its geological position; for it is probably the earliest known species of the genus, except perhaps for two doubtful Liassic forms, which are known only by isolated plates and stem-joints.

Observations on the two Types of Cambrian Beds of the British Isles (*the Caledonian aud Hiberno-Cambrian*), *and the Conditions under which they were respectively Deposited*, by Prof. Edward Hull, LL.D., F.R.S.—In this paper the author pointed out the distinctions in mineral character between the Cambrian beds of the North-West Highlands of Scotland, and their assumed representative in the east of Ireland and North Wales. In the former case, which included the beds belonging to the "Caledonian type," the formation consists of red or purple sandstones and conglomerates; in the latter, which included the beds belonging to the "Hiberno-Cambrian type," the formation consists of hard green and purple grits and slates, contrasting strongly with the former in structure and appearance. These differences, the author considered, were due to deposition in distinct basins, lying on either side of an archæan ridge of crystalline rocks, which ranged probably from Scandinavia through the central Highlands of Scotland, and included the north and west of Ireland, with the counties of Donegal, Derry, Mayo, Sligo, and Galway, in all of which the Cambrian beds were absent, so that the Lower Silurian repose directly and uncomformably on the crystalline rocks of Laurentian age. As additional evidence of the existence of this old ridge, the author showed that when the Lower Silurian beds were in course of formation the archæan floor along the west of Scotland must have sloped upwards towards the east, but he agreed with Prof. Ramsay that the crystalline rocks of the Outer Hebrides formed the western limit of the Cambrian area of deposition, and that the basin was in the form of an inland lake. On the other hand, looking at the fossil evidence both of the Irish and Welsh Cambrian beds, he was of opinion that the beds of this basin were in the main, if not altogether, of marine origin, and that the basin itself had a greatly wider range eastward and southward, the old archæan ridge of the British Isles forming but a small portion of the original margin.

On a Discovery of Fossil Fishes in the New Red Sandstone of Nottingham, by E. Wilson, F.G.S.—The author called the attention of the Section to a recent discovery of fossil fishes in the Lower Keuper Sandstone of England—a circumstance of sufficient rarity in itself, apart from any palæontological results, to deserve at least a passing notice. During the construction of the Leen Valley Outfall Sewer in 1878, a remarkably interesting section was given by the tunnelling driven through Rough Hill, or Colwick Wood, near Nottingham, showing the lower beds of the waterstones resting on a denuded surface of the "Basement Beds" of the Keuper. The lowest stratum of the waterstone was a sandstone about a foot thick, with streaks of red and green marl, and a seam of pebbles at the base. The fishes occurred in this bed, and chiefly in a thin seam of red marl overlying the pebbly seam at the very bottom of the Waterstones; they were present in large numbers, as if in a shoal, for a distance, in the line of section, of about thirty-three feet. The specimens obtained have been examined by several competent authorities, but unfortunately their state of preservation is so bad that nothing certain can be made out as to their precise zoological affinities. Dr. Traquair, however, believes that they probably belong to some species, new or old, of the genus *Semionotus*.

Glacial Sections at York, and their Relation to the later Deposits, by J. Edmund Clark, B.A., B.Sc., F.G.S.—The York area chiefly consists of glacial beds, which form the high ground and various extensive low tracts more or less remote from the Ouse. Glacial depressions have been filled up with brick-earths, and, in exceptional cases, peat-beds. Where the river channel is narrowed below the city, the crests of the banks are capped with gravels. The peat-beds of Campleshon Pond and part of St. Paul's Square rest on the levels covered with brick-earth. Near Ouse Bridge a peat-bed 50 feet down, at Bratt's Brewery, has been called interglacial; but the beds above it cannot positively be asserted to be glacial; for at the waterworks similar beds appear, in which plant-roots were detected 20 feet down. The following sequence of the beds can be established:—

Brick-earths.—At the Harrogate Signals, a quarter of a mile further north, the junction of the upper beds with glacial (or probably glacial) beds is seen. At a few points bosses of boulder clay protrude even here through the upper beds, whilst elsewhere depressions are filled with brick-clays, now extensively worked.

Gravels.—The gravel beds at Fulford and on the opposite side of the Ouse are much alike. The beds are irregular, roughly stratified, with boulders of a quarter-ton weight. The stones are precisely the same as those in the boulder clay; some limestone boulders are still striated. At the gravel pits now being worked on the Bishopthorpe Road a metatarsal of *Ursus spelæus* (or *U. arctos*) was found this spring. There seems to be no previous record of any carnivorous remains from this neighbourhood.

Glacial Sections.—The *deepest* glacial sections were some made in drainage-work at the Friends' Retreat, in 1876, a drift, 650 feet long, cutting through the hill from north-west by west to south-east by east. At the highest point this was 47 feet below the surface. Shafts were sunk every 50 feet. Nothing but glacial beds were met, tough boulder clays, gravelly beds, and sand-beds. The latter were variously inclined and much cut up, rarely continuing any great distance. Indeed everything pointed to the whole mass being made up of independent parts, heaped and piled against each other. The largest boulder brought up weighed about 600 pounds, which is as much as any seen near York *in situ*, except, possibly, one still to be seen on the Mount. Some of those in the museum grounds must weigh more. Among other stones two lumps of coal were brought up. The most extensive series of sections are those on the site of the New Goods Station. For this a level was obtained four acres or so in extent, and 3 to 12 feet below the old surface. Unfortunately there are no records of the sections made in this part. The stones found, though including many from the Lake District, chiefly come from the Carboniferous beds of the West Riding. Limestones are usually scratched and often beautifully polished. At all the places mentioned occasional specimens occur from Lias and Oolite beds, so that an easterly drift must have sometimes counteracted the prevailing set from the west. These glacial beds approach nearest to the purple boulder clay of Messrs. Searles V. Wood and Harmer. Floating ice, however, rather than the *moraine profonde* of an ice-sheet, seems best to account for the mixture of tough boulder-clays with beds of boulders, gravels, and current-bedded sands. The post-glacial deposits are worked to depths of 30 feet and more; in the river-bed they may exceed 50 feet. The river is now 60 or 70 feet above its pre-glacial bed, and probably 40 or 50 above the level to which it first cut down in the opening of the post-glacial epoch.

The Devono-Silurian Formation, by Prof. E. Hull, LL.D., F.R.S., &c.—The beds which the author proposed to group under the above designation are found at various parts of the British Isles, and to a slight extent on the Continent. The formation is, however, eminently British, and occurs under various local names, of which the following are the principal:—

ENGLAND AND WALES

Devonshire.—"The Foreland Grits and Slates," lying below the Lower Devonian beds ("Lynton Beds").

Welsh Borders.—"The passage beds" of Murchison, above the Upper Ludlow Bone bed, and including the Downton Sandstone, and rocks of the Ridge of the Trichrug. These beds form the connecting link between the Estuarine Devonian beds of Hereford (generally, but erroneously, called the "Old Red Sandstone") and the Upper Silurian Series.

South-East of England (Sub-Cretaceous district).—The author assumed, from the borings at Ware, Turnford, and Tottenham Court Road, described by Mr. Etheridge, that the Devono-Silurian beds lie concealed between Turnford and Tottenham Court Road on the south, and Hertford on the north.

IRELAND

South.—"The Dingle Beds," or "Glengariff Grits and Slates," lying conformably on the Upper Silurian beds, as seen in the coast of the Dingle promontory, and overlaid unconformably by either Old Red Sandstone, or Lower Carboniferous beds, 10,000 to 12,000 feet in thickness.

North.—"The Fintona Beds," occupying large tracts of Londonderry, Monaghan, and Tyrone, resting unconformably on the Lower Silurian beds of Pomeroy, and overlaid unconformably by the Old Red Sandstone, or Lower Carboniferous beds, 5000 to 6000 feet in thickness.

SCOTLAND

South.—Beds of the so-called "Lower Old Red Sandstone" with fish and crustaceans, included in Prof. Geikie's "Lake Orcadie, Lake Caledonia, and Lake Cheviot," underlying unconformably the Old Red Sandstone and Lower Calciferous Sandstone, and resting unconformably on Older Crystalline rocks. Thickness in Caithness about 16,200 feet. The author considered that all these beds were representative of one another in time, deposited under lacustrine or estuarine conditions, and, as their name indicated, forming a great group intermediate between the Silurian, on the one hand, and the Devonian on the other. He also submitted that their importance, as indicated by their great development in Ireland and Scotland, entitled them to a distinctive name, such as that proposed.

On the Discovery of Coal-Measures under New Red Sandstone, and on the so-called Permian Rocks of St. Helen's, Lancashire, by A. Strahan, M.A., F.G.S., Geological Survey of England and Wales.—The Trias has been penetrated, during the last few years, by three colliery shafts and three boreholes in the district bordering the St. Helen's and Wigan coal-fields on the south. It was thinner than might have been expected, while the Permian formation was altogether absent. This latter formation was believed to underlie the Trias, but to be overlapped, so as not to appear at the surface, excepting at St. Helen's Junction, where a marl-bed, and a soft sandstone beneath it, 30 and 90 feet thick respectively, and supposed by Messrs. Binney and Hull to be Permian marl and Lower Permian sandstone, were found in a quarry and a well. The Bold Hall Colliery shaft, at about one mile from the outcrop of supposed Permian rocks, proved the shale to maintain its thickness, but the sandstone to be 57 feet 9 inches only. The Coal-Measures were entered at 186 feet, and penetrated to a depth of 1800 feet from the surface, when the Florida Mine was met with. The red staining due to the Trias extended to a depth of 365 feet in the Coal-Measures. The Collins Green Colliery shafts, at the same distance from the boundary of the Trias, but three-quarters of a mile north-east of Bold Hall Colliery, proved the shale to be 22 feet, and the sandstone 44 feet in thickness. The latter contained spherical concretions of iron pyrites, binding the grains of sand in their original position in plains of bedding. The Coal Measures were entered at 310 feet 10 inches, and penetrated to the Florida Mine at 1667 feet 7 inches from surface. They were red for 152 feet. The dip of the so-called Permian was to the south-east at 6°, that of the Coal-Measures at 10°. The Haydock Colliery shafts (Lyme Pits), at the same distance from the boundary of the Trias, are one mile north-east of Collins Green. The shale and sandstone had diminished here to 9 feet and 7½ feet respectively. The Coal-Measures were penetrated to a depth of 97 feet 2 inches, or 413 feet 3 inches from surface. In the shafts of this and the Collins Green Colliery, the unconformity of the red sandstone and the Coal-Measures was clearly visible. The above sections show that the so-called Permian marl and sandstone thin out gradually from west to east, the lower thinning out first, and not the upper, as would have been the case if they had been unconformably overlapped by the overlying beds. They also thin out to the south, as proved by a borehole near Farnworth, three miles south of St. Helen's Junction, which, after penetrating 124 feet of yellow and white sandstone, passed through 3 feet of red and white clay, 3 feet of red sandstone, and entered purple marls with bands of limestone, belonging to the Coal-Measures. The so called Permian beds, though unconformable to the Coal-Measures, are quite conformable to the Trias, and are overlapped in consequence of an attenuation in themselves, and not through having suffered denudation before the Trias was deposited upon them. Considering also their lithological similarity to the Trias, it seems that they should be classed with this formation rather than with the Permian. The Permian rocks are probably absent west of Warrington, for two boreholes at Parkside and Winwick, commencing in the Pebble beds, entered the Coal-Measures at 291 and 341 feet respectively without encountering them. The Trias contained a bed of shale about 30 feet thick, and was based by soft sandstone with twig-shaped concretions of iron pyrites. Like the spherical nodules of Collins Green, these probably owed their origin to the action of Coal-Measure water, with sulphides in solution, acting on the colouring matter (peroxide of iron) of the Trias. The Coal-Measures consisted of purple and green marls, and at Winwick were associated with limestone. They, and the same beds found in the Farnworth boring, are precisely similar to the well-known Whiston limestone, and like it contain the *Microconchus carbonarius*. These limestones are probably the equivalents of the Ardwick limestone séries in the Upper Coal-Measures of Manchester,[1] and may be found to be underlain by representatives of the coal-seams which are found in connection with it. Without doubt they must be everywhere underlain by the whole of the productive Middle Coal-Measures, but at a great and unknown depth, though there is reason to believe that the thickness of barren measures would be less in West Lancashire.

Remarks upon the Structure and Classification of the Blastoidea, by P. Herbert Carpenter, M.A.—The author and Mr. R. Etheridge, jun., who are preparing a joint memoir upon the Blastoidea, have arrived at the following conclusions respecting the group:—It is very doubtful whether the genus *Pentremites* occurs at all in Britain. Some badly-preserved fragments from the Devonian and the Scotch Carboniferous are possibly referable to it; but most of the Blastoids (besides *Codaster*) which occur in the Carboniferous Limestone belong to the genus *Granatocrinus*, Troost., which is represented by some seven or eight species. Cumberland's *Mitra elliptica* is the representative of a new genus, distinguished by the eccentric position of the spiracles. *Codaster* is a true Blastoid, and not a Cystid, as supposed by Billings. The slit-like openings of its hydrospires are nearly on the same level as the ambulacra, which do not conceal them at all. In the ordinary Blastoids, however, they are below and concealed by the ambulacra, opening externally by pores at the sides of the latter. There are various intermediate forms between these two extremes, in which the hydrospiral slits are more or less concealed by the ambulacra, but are partially visible at their sides. It is proposed to group the species thus distinguished into a genus *Pentremitidea*, which is represented in Britain by the little *Pentremites acutus*, Sowerby, in Belgium by *P. caryophyllatus*, and in Spain by *P. Pailleti*, De Verneuil, for which last the name *Pentremitidea* had been already proposed by D'Orbigny. An arrangement of this kind has been already suggested by Billings. The discoveries of Rofe, Wachsmuth, and Hambach, respecting the perforation of the lancet-piece by a longitudinal canal, are confirmed. This canal probably lodged the water-vessel, which must have been devoid of any tentacular extensions, as in some Holothurians, and in the arms of certain *Comatulæ*. Respiration was effected, however, by means of the hydrospires. The pores usually found at the sides of the ambulacra were not the sockets for the attachment of the appendages, but led downwards into the hydrospires, serving to introduce water, which made its way out through the spiracles. The genital ducts probably opened into some portion of the hydrosipres, as they do into the closely similar structures of the *Ophiuroidea*, and the ova were discharged through the spiracles. Billings' statements are confirmed respecting the existence in many species of a single or possibly double row of jointed appendages along each side of the ambulacra; but these appendages are not homologous with the pinnules of the *Crinoidea*. In perfect specimens the peristome is covered in by a vault of small polygonal plates, any definite arrangement of which is rarely traceable. Extensions of this vault were continued down the sides of the ambulacral grooves, which could thus be closed in completely and converted into tunnels, as in recent Crinoids. The classification of the Blastoidea must depend entirely upon morphological principles. Mere differences in the relative sizes of the calyx plates are of very little systematic value; and differences in the numbers of side plates on given lengths of the ambulacra are absolutely worthless. On the other hand, the structure and relative positions of the hydrospires and spiracles are morphological characters of much systematic value.

On the Extension into Essex, Middlesex, and other Inland Counties, of the Mundesley and Westleton Beds, in Relation to the Age of certain Hill-gravels, and of some of the Valleys of the South of England, by J. Prestwich, M.A., F.R.S., Professor of Geology in the University of Oxford.—The author gives in this paper the result of observations commenced more than thirty years since, but delayed publication in consequence of doubts caused by the complexity of the phenomena. As mentioned in the preceding paper, a peculiar group of land, freshwater, and marine beds occupy, on the Norfolk coast, a zone between the Chillesford Clay and the Lower Boulder Clay. As we proceed southward, the land and freshwater conditions are gradually eliminated, and marine conditions then alone prevail. Poorly

[1] This identification was pointed out by Mr. De Rance in the *Trans.* Manchester Geol. Soc. for 1880. ("Further Notes of Triassic Borings near Warrington.")

marked as the marine evidence is in Suffolk, this evidence is entirely wanting further inland, and we have only levels, superposition, and structure to rely on in correlating the fragmentary outliers into which these beds finally resolve themselves. Again on the coast of the Eastern Counties, this group forms a nearly level plain but little above the sea-level, resting everywhere on an undisturbed or very slightly eroded bed of Chillesford Clay, and being succeeded, with but slight evidence of denudation, by the Lower Boulder Clay, or by the Glacial sands and gravel; whereas, as it trends inland, it attains a considerable elevation above the sea-level, passes unconformably over the older Tertiary strata, and has been subjected to a great amount of denudation. On the other hand, the old land, which seems to have extended from the eastward as far as the Norfolk coast, is now in great part below the level of the German Ocean. Further, whereas the succeeding Glacial beds all show a drift from northward to southward, this is the only case that has come under the author's notice of a marine drift from southward to the northward. The Westleton Beds, in their more typical aspect, consist of quartzose sands full of flint pebbles, almost as much worn and as numerous as in the Lower Tertiary sands of Addington. The author then proceeds to trace the beds through Essex, and gives a series of railway sections showing these beds, exhibiting usually the appearance of a white gravel, with intercalated ochreous beds, and reposing on a very eroded surface of the London Clay. In traversing the beds farther westward they undergo further modification. Certain characters remain, however, persistent, and on these we have to rely: (1) The shingle is composed essentially of chalk flint pebbles, becoming less worn as we approach the southern limits of the deposit; (2) it often becomes much mixed with flint pebbles and sub-angular fragments of compact sandstone derived from the underlying Tertiary strata; (3) the chert and ragstone fragments often so increase in numbers as to constitute a large portion of the gravel. They are worn and sub-angular, and the chert is identical with the chert of the Lower Greensand of Kent and Surrey; (4) the pebbles of white and rose-coloured quartz, of Lydian stone, and of white quartzite become rarer, and in places are wanting. The Lydian stone and some of the small quartz pebbles may be derived, with the chert, from the Lower Greensand, but this will not account for the great number of quartz pebbles found in the Eastern Counties. The quartzite pebbles are equally large, but lighter coloured and more ovoid than those of the New Red. They probably have drifted from a continental area on the east, the author having found similar beds in parts of Belgium; (5) the absence of northern drift. The author reserves for another occasion the description of the beds next in order; but he would mention here that the Boulder Clay and some Glacial gravels occupy in Herts and Berks a lower horizon than the Westleton Beds. It would therefore appear that, while the eastern area was submerged, and the strata followed in regular succession upon a surface which did not undergo denudation, the southern and western area was slowly elevated, and underwent partial denudation before the Upper Boulder Clay was deposited. Previous to the period of the Westleton and Mundesley beds, it is probable that the denudation of the Weald had hardly commenced. The area was spread over by Cretaceous strata under water at the beginning of the Crag period (the Lenham beds), and judging from the character of the beds which fringe the North Wealden area at Chelsfield, Cherry Down, &c., the author concludes that there was land south of this fringing shingle, whence the great mass of Chalk-flints and of Lower-Greensand cherts and ragstone must have been derived. This mass of *débris* serves to attest to the great extent of these strata that have been removed from the Wealden area while yet it was an elevated and not a depressed area. After the rise of the area over which the Westleton Beds extended, it underwent extensive denudation, and it was at this period that the great plain of the Thames Valley received its first outlines, although it was not until much later that the river valley received its last impress.

A Contribution to Seismology, by Prof. J. Milne and T. Gray, B.Sc.—It was pointed out that earthquake motion is generally of a very irregular character, that it usually begins gradually, reaches a maximum somewhat suddenly, and afterwards passes through several minima and maxima. The period of vibration of a great number of earthquakes observed by the authors varied between half and one-fifth of a second, while the total time of disturbance varied from one to three minutes. Reasons were given for believing that earthquakes which last for a long time are propagated further than those which last for a short time, even when the intensity of the latter is the greater. As to the determination of the origin of shock, the great value of accurate time observations was pointed out, and a sketch of different modes of making such observations was given. Explanations were entered into with regard to the rotation of bodies during earthquake shocks.

The Glacial Geology of Central Wales, by Walter Keeping, M.A.—The author adduces evidences to show that Central Wales was covered with snow and ice during the glacial period, but all the glaciers of which we have any traces were of strictly local character, each confined to its own drainage area in the present valley system. There is no evidence of any great *mer de glace*, nor of any marine submergence in recent geological times.

On the Lower Keuper Sandstone of Cheshire, by A. Strahan, M.A., F.G.S., Geological Survey of England and Wales.—This paper deals with some of the results of the re-survey of parts of Cheshire, which have been already described in detail in the Geological Survey Memoirs "On the Neighbourhood of Prescot" (third edition), and "On the Neighbourhood of Chester." Several sections, of which the best are at Runcorn and Frodsham, show that there is a strong and constant division between the waterstones and the Keuper Basement Beds. These were formerly classed together under the name of Lower Keuper Sandstone, but, so far as the re-survey has been carried, are now distinguished on the maps. The old and new classifications may be compared as follows:—

Old Classification.	New Classification.
Keuper Marl...	Keuper Marl.
Lower Keuper Sandstone ...	Waterstones. Lower Keuper Sandstone or Basement Beds.

SECTION D—Biology

Department of Anatomy and Physiology

On the Conario-hypophysial Tract, or the Pineal and Pituitary Glands, by Prof. Owen, C.B., F.R.S.—The author, referring to the latest contributions to the subject of his paper, remarked that they bore upon the functions of the so-termed "glands." Prof. Sapolini, in his work "L'Aire de la Selle Turcique" (8vo, 1880), concludes that "the pituitary gland secretes the fluid of the ventricles of the brain." Prof. Ed. Van Beneden, in reference to the supposed pituitary gland in Ascidians, regards it as their renal secretory organ (*Archives de Biologie*, 8vo, 1881). In pursuance of his aim, which was homological, Prof. Owen traced the modifications of the pineal and pituitary bodies and connecting parts from man down to the lowest fishes possessing a brain; and noted the progressively increased relative size and retention of tubular structure of the tract, including the so-called "pituitary gland," "infundibulum," "third ventricle," and "pineal gland," as the vertebrate series descended; also the further extension of the pineal part of the tract, beyond the brain, to its perforation of the cranium, leaving the so-called "foramen parietale" in some existing and in many extinct Reptilia. These phenomena were then tested and compared with concomitant phases in the development of the vertebrate, especially the mammalian, embryo. It was shown, as had been noted by previous embryologists, that prior to the permanent anterior outlet of the digestive sac, a production from such sac extended to the large cerebral vesicle, subsequently reduced to a "third ventricle"; whence the hollow tract was continued onward to the epithelial covering of the head, by which it was closed. The lower pharyngeal beginning of this trans-cerebral tract also became closed and modified as the "pituitary body." The upper continuation became modified, and in higher vertebrates closed as the "pineal body"; but the intermediate portion of the tract retained its primitive hollow condition as the "third ventricle" and "infundibulum." The "sella turcica" in mammals, like the "foramen parietale" in cold-blooded vertebrates, were modifications in the skeleton of parts of the "conario-hypophysial tract." This tract, under all its modifications, marked vertically the division between the "cerebrum" and the "optic lobes," or divided the "fore-brain" from the "hind-brain."

The author next proceeded to point out the homologies of the parts of the neural axis in invertebrates with those of vertebrates.

The so-called "supra-œsophageal ganglion or ganglions" in the former were homologous with the "cerebrum, or cerebral hemispheres" in the latter. The so-called "sub-œsophageal masses" in invertebrates answered to the mes-and ep-encephalic